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Identifying Scotomata in Hazard Identification Caused By Ignorance and Overconfidence

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Abstract

The manufacturing and construction industries are two of the most dangerous professions, and employees are frequently exposed to hazards and hazardous conditions which can lead to serious injury or even death. An observed phenomenon, frequently called the Dunning-Kruger Effect states that unskilled people are often unaware of their shortcomings and those with the higher-level skills often underestimate their abilities. This study examines employees' training, years of experience, and performance to gauge any correlations among these variables in the area of hazard awareness. The goal of this study is to help individuals to recognize blind spots in their knowledge to identify hazards in various situations to keep themselves and others safe.

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Introduction

This study was designed to determine how an individual's confidence, competence, and training influence an individual's performance in identifying hazardous situations within the workplace. The goal is to show any internal biases that might affect the value of safety training to help employee recognition of hazards to reduce the number of workplace injuries.

According to the U.S. Bureau of Labor Statistics, in 2019 workers in private industries incurred 2.8 million non-fatal workplace injuries or illnesses. This is a rate of 2.8% of all full-time workers, or 2.8 cases per 100 workers. This was the same amount that was reported in 2017 and 2018 [1]. According to the National Council on Compensation Insurance's (NCCI) database, the average cost of all work's compensation claims was $41,003 for 2017-2018. The top causes of work's compensation claims resulted from motor vehicle crashes, burns, falls/slips, and being caught by something. The most frequent categories of worker's compensation costs were amputations, fractures/crushes/dislocations, trauma, and burns [2]. In 2019, there were 5,333 workers who died from a work-related injury, which was an increase of 2% from 2018, equating to 3.5 fatal accidents per 100,000 full-time workers [3].

The education and training of employees is one of the most important tools that companies can use to keep their employees safe. Many different training programs and aids have been created by the Occupational Safety and Health Administration (OSHA) to assist employers in maintaining safe work environments for their employees. These programs provide employees with the knowledge and skills needed to perform their jobs safely, the awareness of workplace hazards, and how to identify, report, and control them, as well as any special training due to unique hazards [4]. By utilizing effective training methods, companies can reduce the amount of

non-fatal and fatal workplace injuries by equipping employees with the skills and knowledge to identify hazards and potential hazards [5].

The primary study from where this study was inspired is Justin Kruger and David Dunning's study titled "Unskilled and Unaware of It." Their findings became known as the Dunning-Kruger Effect. Their study found that incompetent individuals are often overconfident in their abilities and are often unable to see the gaps of information that they knew. Their study also found that competent individuals tend to underestimate their skills and their knowledge. Since the original study in 1999, there have been numerous studies that have identified this effect in various fields. This study examines the effect in the area of hazard awareness.

Significance

This research is important because it can show deficiencies in the effectiveness of safety training as a result of intrinsic biases and lead to safer workers in the workplace and reduce the number of injurious incidents that occur. There were over 2 million non-fatal, work-related injuries and over 5,000 fatal workplace injuries occurring in the U.S. in 2019 [1] [3]. One key area that might lead to a reduction in workplace injuries could be improving self-awareness of employees. With more in-depth and engaging training programs, along with follow-up and refresher courses, employees can be better equipped to identify hazards and know how to respond to those situations.

The information obtained in this study can also serve as a reference for safety trainers by helping identify some common blind spots and misconceptions that many employees might have about various hazards. This could help trainers find more effective ways of educating employees on these topics so that they can practice safe workplace behaviors while on the job.

Research Questions

This study examined three areas that could be key deciding factors in one's ability to identify safety hazards. The following questions lead to the creation of a research triangle (Figure 1).

Question 1

Is there a significant relationship among different types of Environment Health and Safety (EHS) training certifications or degrees and their performance in their ability to identify hazards?

Question 2

Is there a significant relationship between one's confidence in identifying hazards and their performance in their ability to identify hazards?

Question 3

Is there a significant relationship between one's training in EHS and his or her confidence in identifying hazards?

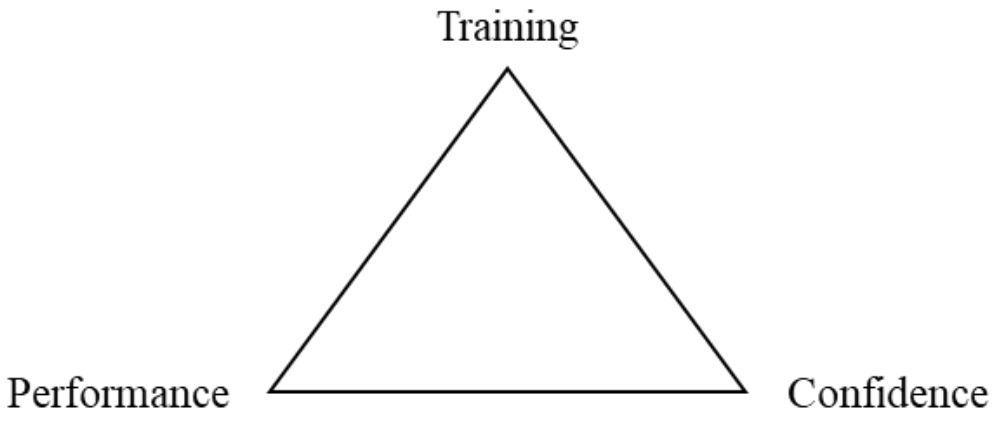

Figure 1 Research Question Triangle

Problem Statement

The construction industry and manufacturing industry are two of the most dangerous industries in the United States. These industries are constantly exposed to many hazards that could lead to severe injury or even death if not handled appropriately. This study looks to determine blind spots in hazard recognition that may be influenced by training or overconfidence.

Purpose

The purpose of this study is to provide more information for individuals to improve their awareness of hazards and respective blind spots, or scotomata. The study provides insight to trainers and employers as to the effectiveness of training.

Limitations

There were a few limitations that were present when gathering information via online surveys. We cannot do anything about dishonest answers or skipped questions. There is also an accessibility issue where only individuals with email addresses or internet access are able to partake in the survey.

Delimitations

Some of the delimitations of this study that were able to be controlled were the population, the variables being tested, and the statistical analysis being performed. The population that was invited to take part in the study was individuals from various industrial groups and professional organizations primarily involved with manufacturing and construction. We were also able to prevent multiple responses from the same respondent by setting up the survey to only allow one response from each IP address. By asking these individuals, the study will encompass a large variety of people who have varying levels of experience and abilities at identifying hazards. The variables that were being identified were individual's self-assessments of how safe they believe they are and how well they are able to identify hazards from photographs. Once all the information was collected, the overall scores were tabulated and a multiple linear regression was used to determine if there is any statistical significance among confidence, performance, and training.

Literature Review

Dunning-Kruger Effect and Other Similar Studies

The original study which this study is based was performed by Justin Kruger and David Dunning at Cornell University in 1999. Their study, *Unskilled and Unaware of It*, was designed to assess humans' metacognitive competence, and help individuals recognize the limitations of their abilities [6].

Their study found that incompetency, "not only causes poor performance, but also the inability to recognize one's performance is poor" [6]. During all four of the studies that Kruger and Dunning conducted, participants in the bottom quartile overestimated themselves and felt that they were above average in their performances. These individuals not only performed poorly, but also failed to recognize that they performed poorly. It was also observed that the participants in the top quartile tended to underestimate their ability and their test performances relative to their peers. This group failed to recognize that the level of knowledge that they possessed was not shared by the peers. The study linked one's level of metacognitive skills with one's ability to judge their performance. It was found that by improving an individual's metacognitive skills, they are also able to improve the accuracy of their self-appraisals [6].

Some key findings that this study found were that not everybody overestimates their abilities or performances. They found that the poor performers often believe that they are doing just fine with their performance and fail to recognize just how incompetent their performance is. The study also concluded that top performers judge their decisions accurately but overestimate how other people perform on the same tasks [7].

Dunning and Kruger's study has also been replicated several times studying different categories such as reasoning, humor, grammar, leadership, driving, aviation, dating popularity,

academics and continuing professional development. Many of these studies utilized similar experimental designs using pre-exams to ask participants about their experiences and perceived skills on a scale of 1-10. The studies then presented the test to the participants. The results were then always graded and scored before analysis was performed [8].

The findings of these secondary studies confirmed many of findings of the original Dunning-Kruger study. It was found that individuals who lack competence overestimate their abilities (illusory superiority), and individuals with higher skillsets underestimate their ability (illusory inferiority) [9]. These studies also found that some sources of the error in one's self-assessment are one's self-views and skill level. Self-skills are their perception of the situation, and their skill levels are how much they know about the topic [10].

The effectiveness of self-assessments "depend on the individual's ability to self-assess gaps in their competence, and their willingness to seek out opportunities to reduce those gaps when identified" [11]. Self-assessments are often not effective tools for identifying weaknesses because humans tend to avoid engaging in learning to fill any blind spots because that would require more energy and a commitment and willingness to change [11].

There are many reasons that people have biases or blind spots in their knowledge resulting from overconfidence. Some of those reasons are: 1) learning can be more difficult in some settings than others, 2) different behavioral biases may reinforce each other, or 3) rules of thumb can spill over to other contexts. [12]. This study suggests that learning a skill because "that's how we do it" may not be beneficial to employees in the long-run and may cause overconfidence. Overconfidence can be defined as the overestimation of one's actual performance, over-placement of one's performance compared to others, or excessive precision in their beliefs [13].

When studying students in higher education, one study found that students often predicted their performance on exams to upwards of 30% better than they actually scored. However, higher performing students were much closer in predicting their scores. It was concluded that the under-performers lacked metacognitive insight to realize their shortcomings. They also found that the higher-performing students were often correct in their assessments, yet lacked the confidence of their metacognitive skills [14].

David Dunning has also done further research examining the Dunning-Kruger effect, both with Justin Kruger, with other researchers, and by himself. One study that Dunning did by himself focused on people's patterns of error in judgement. He found that the individuals doing the judging also have gaps in their skills and knowledge. Dunning calls this a ceiling of competence. Each person's imperfections are also impairments in their performance or judgement [15]. He also concluded that the incompetent people are not the only individuals effected by their incompetence, but they also effect the individuals who are around them. In a section titled "Managing the Incompetent", Dunning claims that it is hard for others to work with the incompetent because they often don't know that they need advice, and the feedback that they receive is not always effective because they often resist negative feedback [15]. He also discusses some of the burdens of top performers because they tend to misjudge their own knowledge because they feel that if they know the information, then others should too, and their genius is often unrecognized [15].

Another study that Dunning performed looked at self-assessments within the workplace. The study found that people overrate themselves, and that flawed self-assessments occur all the way up the corporate ladder [16]. People also have a tendency to hold inflated self-views that exceed their actual performance abilities. The study also states some challenges associated with

providing employees with feedback such as: feedback is infrequent, feedback is threatening, feedback is sugarcoated or feedback is given too late [16]. Although this feedback may still be useful, to obtain better results, feedback should be given more regularly, and on less-formal basis to appear less threatening [16].

Within the workplace, the Dunning-Kruger effect can be applied to risk decisions and safety as well. Often, safety standards elaborate on the avoidance of risk, and not much is said about the judgement of the risk [17]. Some studies have even suggested that instead of spending money on costly safety trainings, they should begin to rely on choosing safer workers when hiring new employees, rather than cultivating from within. This study believed that it was difficult to change the perceptions of tenured employees because they may be more susceptible to pitfalls due to adopted norms to cut corners to meet performance expectations [18].

Workplace Safety and Injury Prevention

One common method to help mitigate workplace injuries is Occupational Health and Safety (OHS) training. Many recommend workplaces continue to deliver OHS training to their employees, since it has shown to have a positive impact on work practices within the workplace [19].

One study aimed to identify effective training processes in regards to Occupational Health and Safety. This meta-analysis examined several articles that delt with workplace training and safety to gain a better understanding of common training methods and the effectiveness of them. It was believed that “specific training in hazard identification, mentoring of supervisors and the introduction of a robust safety system… could improve organizations’ safety culture” [20].

It was found that 53.6% of all training was done in the form of classroom theory lessons (lectures), 12% in the form of e-learning and only 8% had hands-on practice. 57% of the safety trainings were completed in a single session, and 69.2% of the sessions lasted 1 hour or less. These trainings focused primarily on accidents (46.4%) and ergonomic hazards (42.9%), and very few studies addressed biological dangers, or physical risks, and none discussed chemical exposures [20].

Many different sectors were studied during this meta-analysis. The primary industries where training occurs are the construction industry (28%), farming industry (24%), and manufacturing (12%). Many of these trainings were often directed towards individuals via one-on-one training, whereas fewer did small groups; only one group conducted trainings with large groups of more than thirty-five trainees at a time. [20].

The study also examined the follow-up appraisals that were conducted. The most common form of assessment was in the form of a questionnaire (65.9%), observations on the job (13.6%) and practical tests (9.1%) [20].

It was found that training had a positive effect on the knowledge gained by employees. After completing their training, it was indicated that employees had a more favorable attitude towards preventative behaviors and adopted a more safety-minded mindset [20].

It has been found that the more engaging the training, there is a greater acquisition of knowledge retention, and will have a greater impact on reducing injuries. A study conducted by Burke and colleagues in 2006 found that more engaging safety training methods were approximately three times more effective than less engaging methods of training such as classroom lectures or written materials. These better methods included such techniques as:

hands-on demonstrations, videos, dialogue, conversation, and interactions between the trainer and the trainees, or active participation components in computer-based training seminars [21].

No matter the training method, it is everyone's responsibility to create a safe work environment; this so all the way from the youngest or newest employees all the way up to the leaders and owners.

An Australian study conducted in 2018 found that younger workers are 17% more likely to suffer from a work-related injury [22]. The article mentions some things to consider when managing younger and newer employees. The things to remember are: they have limited or no workplace experience, they are less aware of OHS risks and responsibilities, they may be reluctant to ask questions or speak up, they may be overconfident in their capabilities, or they want to make a good impression and jump into situations without thinking about safety [22]. In order to maintain a safe work environment, one can: follow all reasonable instructions and workplace procedures, wear personal protective equipment as required, and report unsafe situations or injuries to supervisors and other employees. The article also suggest having newer employees familiarize themselves with the health and safety requirements of the workplace and to ask for assistance and training to ensure that they complete all tasks safely [22].

Although it is each worker's responsibility to ensure that they are safe and do not perform risky operations or tasks, it is also the responsibility of managers, supervisors, and upper management to ensure that employees have safe environments to work. A 2010 article published in the Professional Safety Journal said that, "creating an organization that eliminates fatalities and life-altering injuries cannot be delegated. It requires the integrated involvement of the entire organization, from the CEO to each worker" [23]. Another journal found that companies which emphasize safety, concern of workers and compliance with regulations find themselves with

fewer OHS issues [24]. This shows that when leaders make safety a priority, not just production, the entire organization has a better acceptance towards safety practices and can create safer working environments.

Methodology

Research Design and Theoretical Framework

This study used an online survey questionnaire sent out via email blasts to individuals that asked them about their background and previous trainings and certifications related to safety. The survey then asked them to rate their confidence in various categories within the construction industry and the general [manufacturing] industry on a scale of 0-10. The participants were given 10 randomized images from a question pool of 25 pictures and were asked to click on any part of the image in which they identify a hazard. This survey can be found in Appendix B: Survey. The data was then gathered from the surveys and statistical analysis was conducted to find any correlations that exist with statistical significance.

Assumptions

This experiment assumed that individuals completed the surveys honestly and provided accurate information about their background knowledge and confidence about safety. It is also assumed that individuals gave their best effort during the portion of the survey where they were asked to identify the hazards that they recognized within the images they were given.

Description of Participants

The survey was distributed via an email blast to a national Engineering Technology Database listserv (ETD Listserv), EIU's Engineering Technology Advisory Board, EIU's Lumpkin College of Business and Technology Leadership Team, as well as a risk management consultant contact working in the workman's compensation insurance industry. Within the email blast, the respondents were encouraged to forward the survey to anyone else that they thought

might participate in the survey. It was also emphasized that no background in the field of safety was necessary to participate.

Data Collection

For this research experiment, a survey was conducted using Qualtrics and the results were stored within the program. The information was exported to Microsoft Excel to be graded. The raw data that was collected and graded can be found in Appendix C: Raw Data Tables. Any incomplete survey responses were thrown out and not used for the statistical analysis. For the grading process, an answer key was created prior to starting, which identified the known hazards within each picture. For each correctly identified hazard in an image, the respondent received +1 points. For each incorrectly identified hazard or for clicking on an area that was not a hazard received -1 points. Therefore, a maximum score was determined for each image, with a possible minimum score of negative infinity. Once each image had been graded from the respondent, a normalized score could be assigned to the respondent as well as scores for their performance in the specific categories that they received pictures. In order to obtain a normalized score for each respondent the following two formulas were used:

$$Normalized\ Score = \frac{Raw\ Score}{Max\ Score}, \text{ if the raw score} \geq 0$$

$$Normalized\ Score = -(\frac{Max\ Score - Raw\ Score}{Max\ Score}), \text{ if the raw score} < 0$$

The raw score was calculated by the total number of correctly identified hazards from all of the respondent's images subtracted from the number of missed hazards and false clicks. Each respondent's max score was calculated by the total number of determined hazards for each image based off of the answer key and the images that were randomly assigned to them.

Analyses were performed to determine the association between training and confidence with performance. Bivariate correlation and regression analyses were first conducted to

determine the bivariate associations, with multivariate regression models (MLR) then being performed to determine if the bivariate analyses would be attenuated. Post-hoc power analyses were also performed to determine the power of the study, in order to determine the necessary effect size to be powered with the current sample size at a power level of 0.80. All analyses were performed using SAS v9.4 (SAS Institute, Cary, NC) and all analytic assumptions were verified, with non-parametric tests being used when necessary.

Results and Discussion

There were 91 total respondents who took the survey. Of those respondents, 68 of the responses were complete and were used for the calculations and analysis for this study. The 23 incomplete responses were thrown out.

There was a wide array in the demographic that participated in the study. The largest portions of the population were, managers/supervisors, professors/teachers, and consultants, respectively. Figure 2 and Table 1 show the breakdown of the jobs held by the respondents.

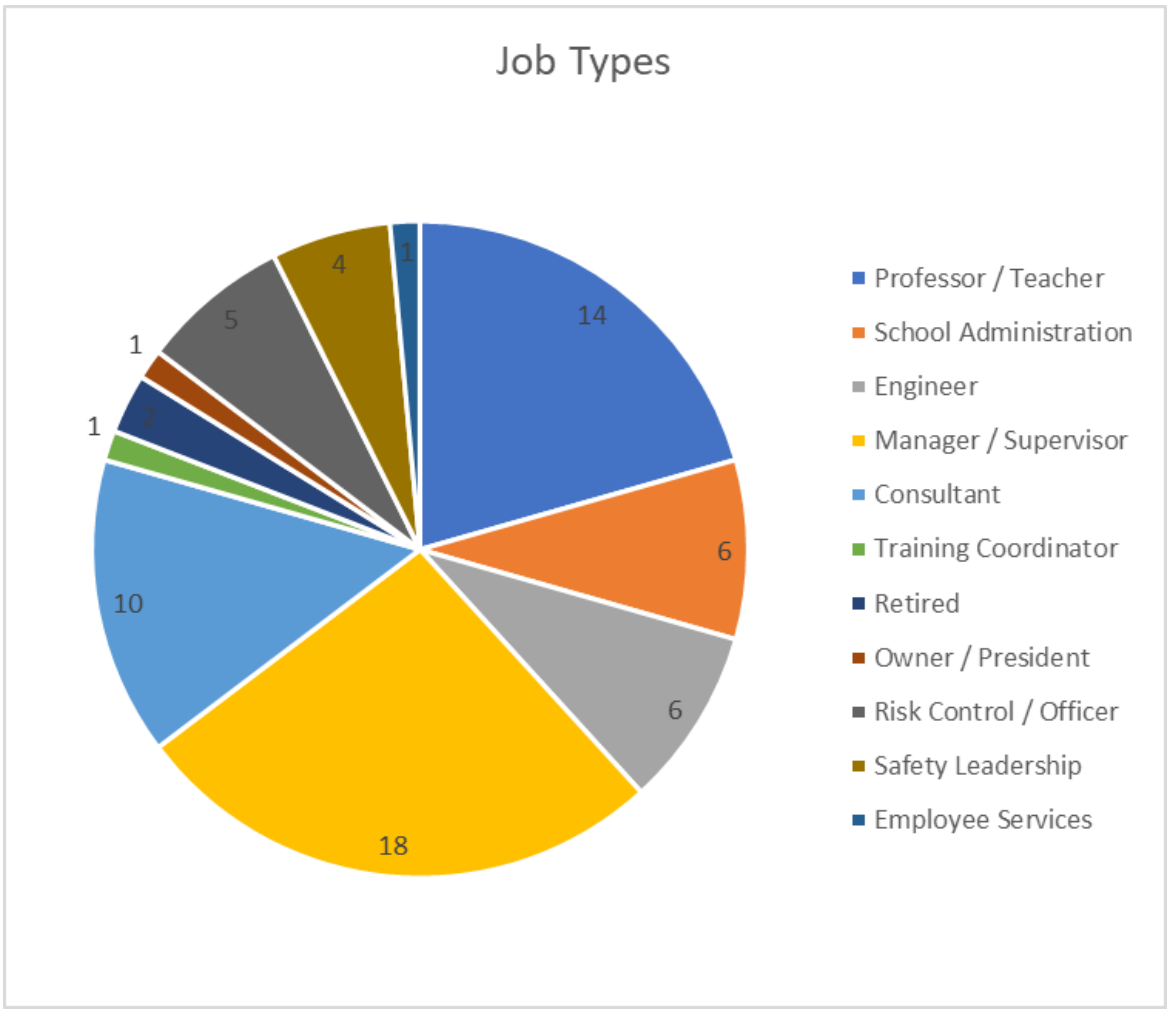

Figure 2 Pie Chart of the Job Types of the Respondents

Job Categories	# Respondents
Professor / Teacher	14
School Administration	6
Engineer	6
Manager / Supervisor	18
Consultant	10
Training Coordinator	1
Retired	2
Owner / President	1
Risk Control / Officer	5
Safety Leadership	4
Employee Services	1

Table 1 Summary Table of the Job Categories of the Respondents

Most of the respondents had over 21 years of experience in their respective industries. Very few of the respondent had minimal experience within their industry. Figure 3 and Table 2 show the breakdown of the years of experience of the respondents.

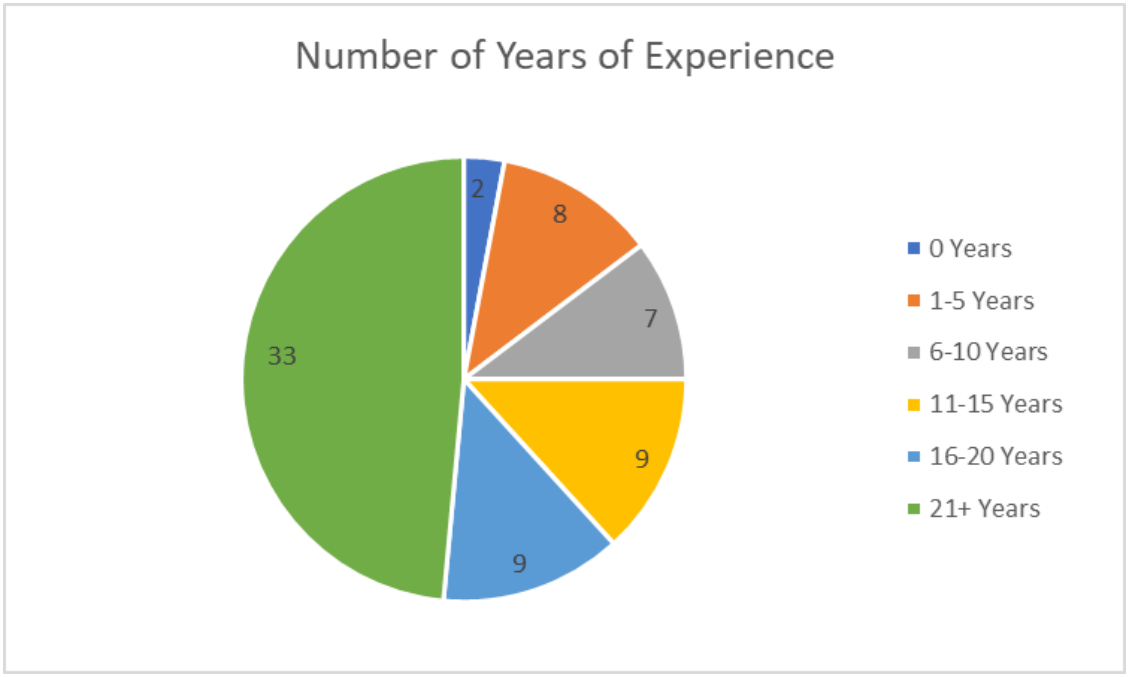

Figure 3 Pie Chart of the Years of Experience of the Respondents

Years of Experience	# Respondents
0 Years	2
1-5 Years	8
6-10 Years	7
11-15 Years	9
16-20 Years	9
21+ Years	33

Table 2 Summary Table of the Years of Experience of the Respondents

There were many different certifications and degrees that were held by the respondents (Table 3). The certification that the most respondents possessed was an OSHA 10-Hour for General Industry certification. There was also a decent number of individuals who had other certifications that were not specifically asked about. However, there was a large portion of the population that only received on-the-job training. Figure 4 and Table 3 show the different certifications and degrees held by the respondents.

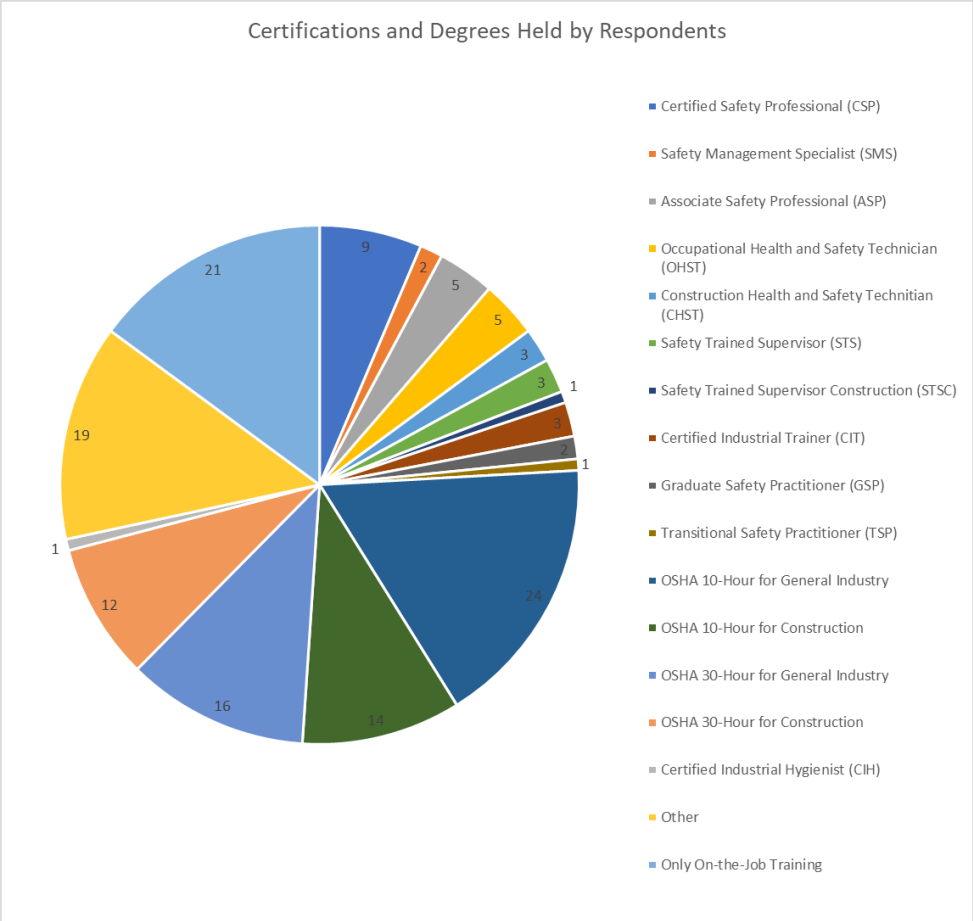

Figure 4 Pie Chart of the Certifications Held by the Respondents

Certification / Degree	# Respondents
Certified Safety Professional (CSP)	9
Safety Management Specialist (SMS)	2
Associate Safety Professional (ASP)	5
Occupational Health and Safety Technician (OHST)	5
Construction Health and Safety Technitian (CHST)	3
Safety Trained Supervisor (STS)	3
Safety Trained Supervisor Construction (STSC)	1
Certified Industrial Trainer (CIT)	3
Graduate Safety Practitioner (GSP)	2
Transitional Safety Practitioner (TSP)	1
OSHA 10-Hour for General Industry	24
OSHA 10-Hour for Construction	14
OSHA 30-Hour for General Industry	16
OSHA 30-Hour for Construction	12
Certified Industrial Hygienist (CIH)	1
Other	19
Only On-the-Job Training	21

Table 3 Summary of the Certifications Held by the Respondents

Once the responses had been scored, the results could be analyzed to determine if there were any correlations between certification types and normalized scores, expected scores and normalized scores, and certification types and expected scores. A summary table of years of experience, normalized scores, and expected scores was created to be used for the MLR. This information can be found in Table 4. The MLR indicated that neither training nor confidence were positively associated with performance. Training was positively associated with confidence, which was not associated with attenuated in the MLR models including confidence. The correlation summary table was also used to run a Pearson correlation analysis (Table 5). For the Pearson correlation analysis, the outliers (the individuals who received positive scores) were removed. The analysis showed that there was a statistically significant result in the correlation between years of experience and their expected score. It was found that the more years of experience an individual has, the better they believe they will be able to identify hazards. There were non-significant results between the normalized score and years of experience and with normalized score and expected score.

The empirical regression model, i.e. equation, for the relationship between years of experience and normalized score has a p-value of 0.3290 from the experience variable. The equation for that model is:

$$Score = -1.44 - 0.002(experience)$$

The empirical regression model, for the relationship between experience and expected scores have p-values of 0.4578 and 0.5876 respectively. The equation for this model is:

$$Score = -1.40 - 0.002(experience) - 0.009(expected)$$

The low value of these coefficients and the high p-values indicate there is little influence on the normalized score (performance) from either expected score or experience. That is, at this sample

size, performance cannot be reliably predicted based upon the respondent's experience or expected score.

A power analysis was also performed with the data from Table 4. The outliers were again removed prior to running the power analysis. With n=62, the study was powered at 80% with the usual alpha of 0.05. This would make a correlation coefficient of 0.35. That is why the correlation coefficient for the years of experience and expected score (0.32570) was significant. The power analysis also showed that to be powered to find a statistically significant results with a smaller correlation of years of experience with expected score, the sample size would need to be n=647. This did not show that the sample was undersized or underpowered, there just wasn't much statistical information with experience and score.

X-Y graphs were also created from the MLR data to show the relationships between total scores and years of experience (Figure 5), expected scores and years of experience (Figure 6), and total scores and years of experience (Figure 7). Figure 8 depicts a histogram showing the distribution of individuals self-reported expected scores. Figure 9 depicts a histogram showing that the majority of respondents received a negative overall score between -1.03 and -1.93, with only a few individuals receiving positive overall scores.

#	Years	Normalized Score	Expected Score
1	5	-1.69	6.07
2	15	0.03	1.00
3	9	-1.48	4.80
4	42	-1.81	9.73
5	12	-1.48	1.80
6	1	-1.17	4.87
7	5	-1.41	7.87
8	40	-1.45	4.27
9	35	-1.50	5.27
10	35	-1.23	8.40
11	40	-1.25	4.47
12	30	-1.86	8.20
13	1	-1.61	4.60
14	50	-1.28	5.40
15	12	-1.21	7.33
16	5	-1.48	6.33
17	2	-1.95	4.00
18	0	-1.13	3.53
31	5	-1.60	6.13
32	11	-1.43	4.47
33	30	-1.35	7.40
34	25	-1.58	6.47
35	37	0.00	9.27
36	17	-1.24	4.20
37	25	-1.32	4.27
38	25	-1.65	5.40
39	15	-1.31	2.40
40	17	-2.05	7.87
41	8	-1.07	4.33
42	16	-1.23	3.33
43	21	-1.54	1.07
44	5	-1.42	6.60
45	21	0.32	8.67
46	25	-1.26	8.67
47	36	0.28	7.27
48	40	-1.80	6.67
49	0	-1.42	1.53
50	19	-1.35	4.40
51	18	-1.14	8.00
52	35	-1.76	7.13
53	41	-1.87	8.53
54	35	-1.75	4.73
55	46	-1.58	10.00
56	6	-1.52	5.40
57	35	-1.48	3.73
58	25	0.08	9.47
59	30	-2.38	7.60
60	9	-1.57	6.80
61	20	-1.59	2.67
62	8	-1.45	8.40
63	17	-1.52	9.13
64	7	-1.50	5.53
65	16	-1.48	4.93
66	10	0.16	7.07
67	12	-1.71	5.33
68	12	-1.09	8.27
69	15	-1.63	3.40
70	23	-1.17	7.73
71	21	-1.48	8.53
72	13	-1.69	3.73
73	25	-1.39	5.07
74	17	-1.22	7.73
75	27	-1.46	4.60
78	20	-1.74	8.13
79	28	-1.48	4.67
86	40	-1.10	8.47
90	42	-1.32	8.40
91	29	-1.68	6.80

Table 4 Summary Table of Respondent Responses

	Years of Experience	Expected Score	Normalized Score
Years of Experience		0.32570; p=.0098	-0.12603; p=.3290
Expected Score			-0.10747; p=.4057
Normalized Score			

Table 5 Pearson Correlation Analysis

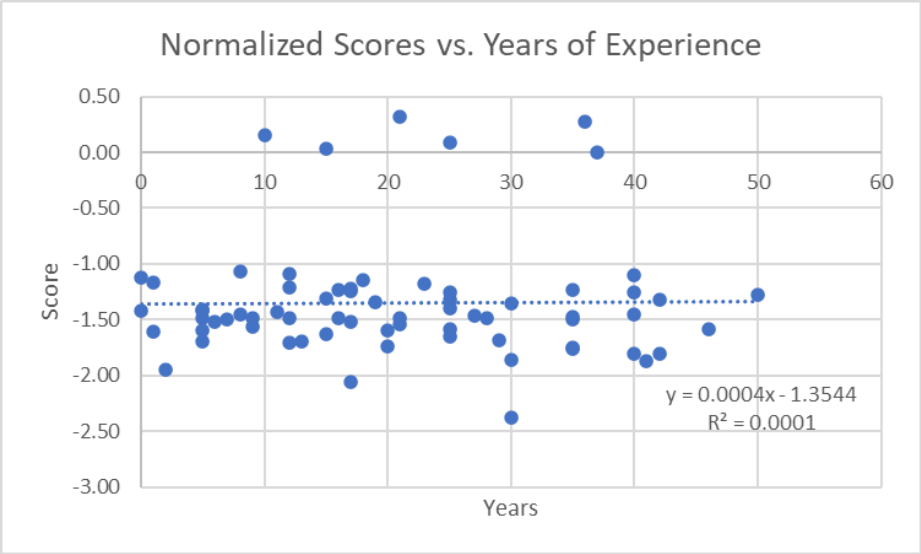

Figure 5 X-Y Plot of All Normalized Scores vs. Years of Experience

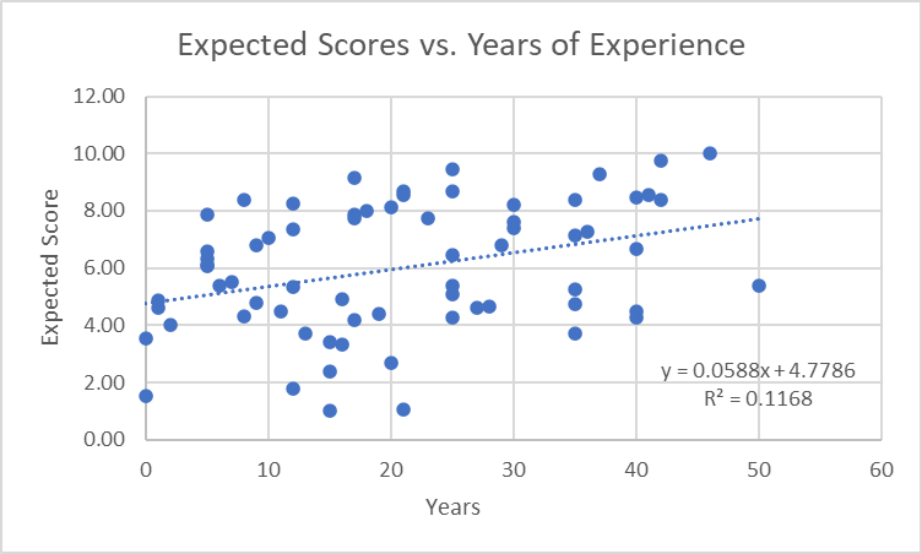

Figure 6 X-Y Plot of All Expected Scores vs. Years of Experience

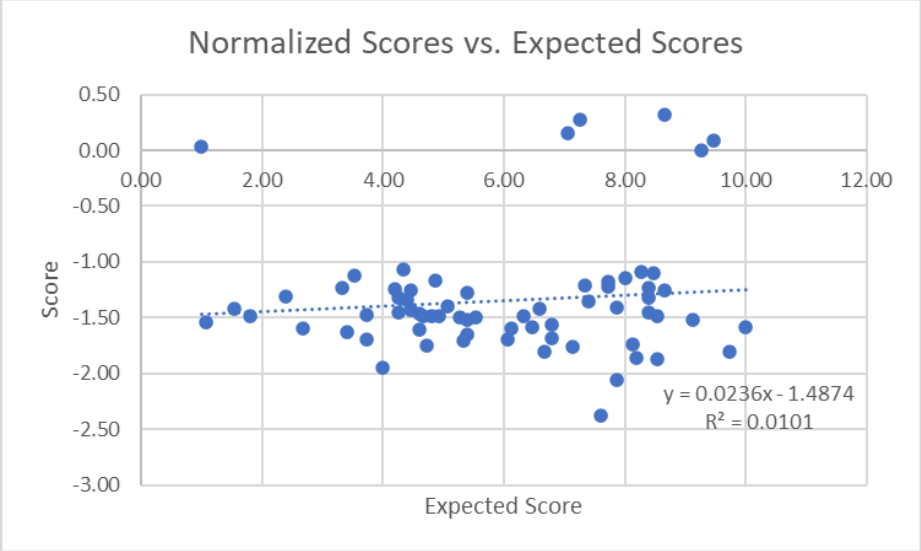

Figure 7 X-Y Plot of All Normalized Scores vs. Expected Scores

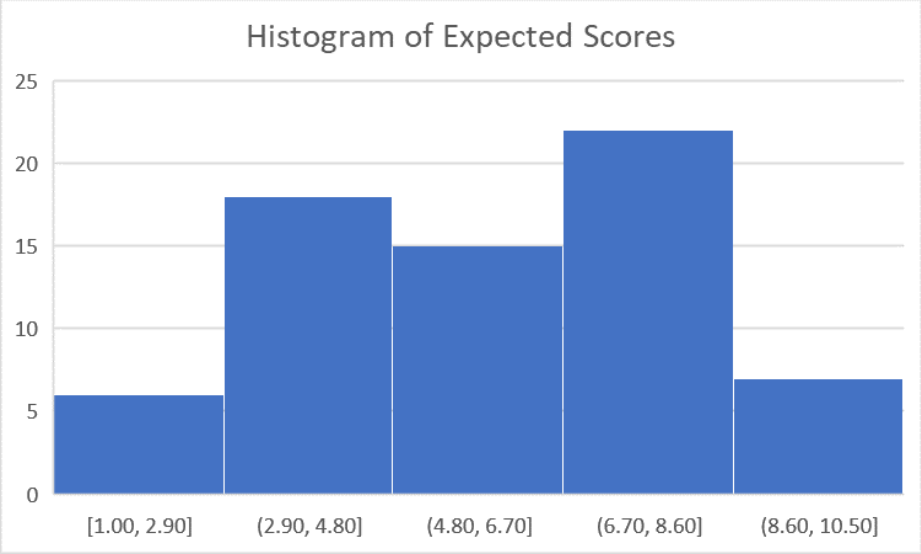

Figure 8 Histogram of All Expected Scores

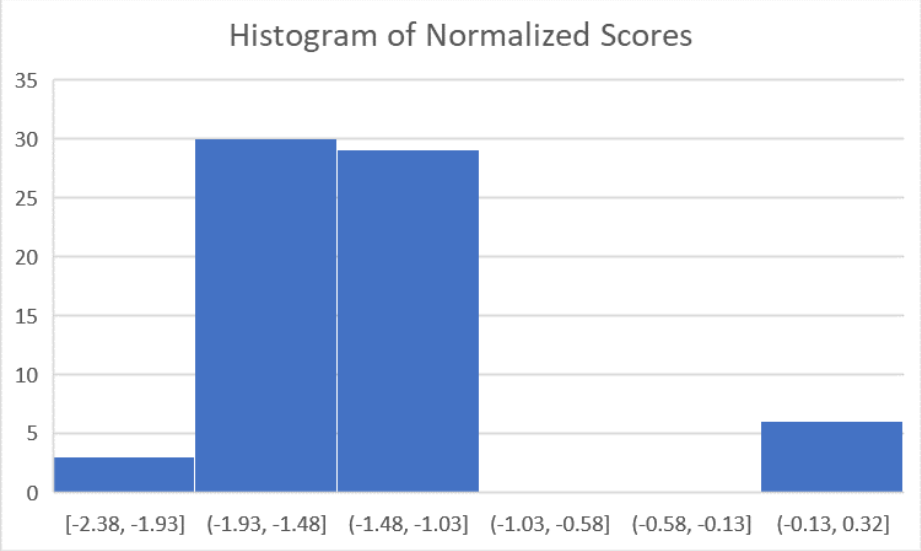

Figure 9 Histogram of All Normalized Scores

The next thing that was examined was if there were any certification types that performed better than others. For this analysis, a summary table of the average normalized scores and average expected scores for each certification type was created. These results can be seen in Table 6. The data was also graphed using a double bar graph and can be seen in Figure 10. To

obtain these averages, each overall score was sorted by the different categories of certifications. The individual normalized scores and expected scores for each category can be found in Appendix C: Raw Data Tables. Those data points were then graphed using a box and whisker plot (Figure 11).

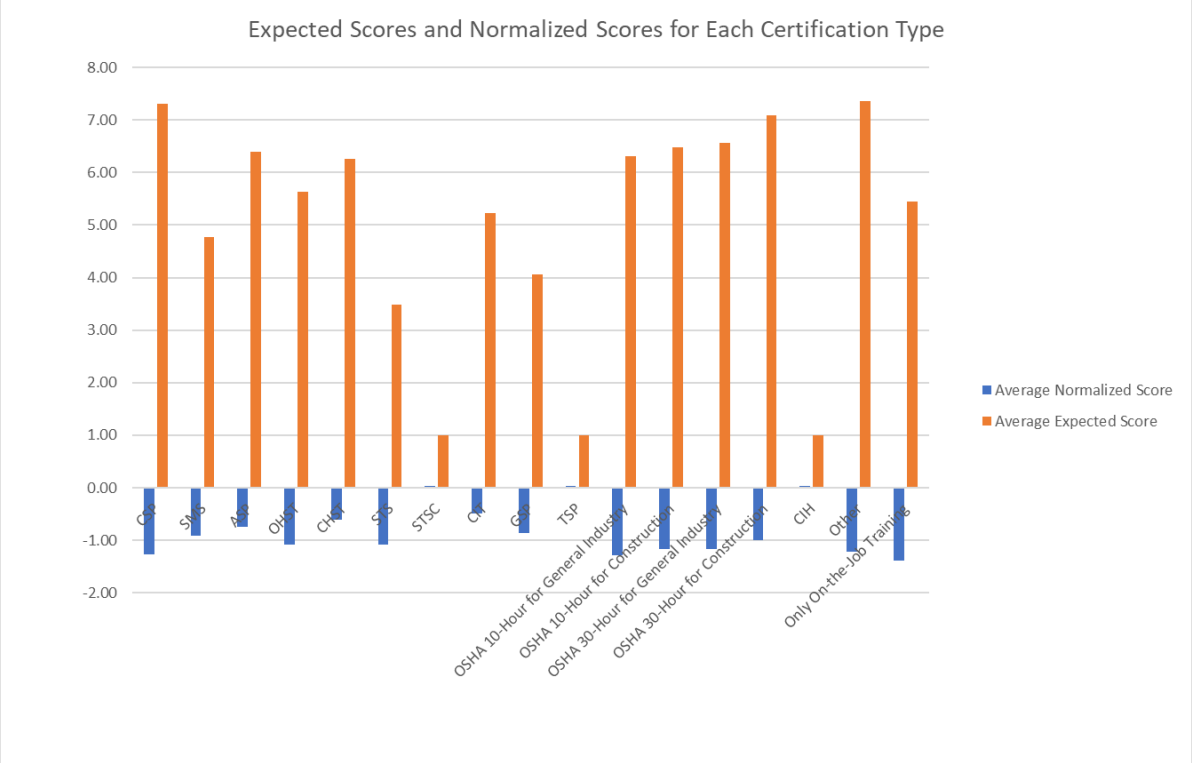

Figure 10 Bar Graph of Expected Scores and Normalized Scores for Each Certification Type

Certification / Degree	Average Normalized Score	Average Expected Score
CSP	-1.27	7.30
SMS	-0.92	4.77
ASP	-0.74	6.39
OHST	-1.09	5.64
CHST	-0.61	6.27
STS	-1.08	3.49
STSC	0.03	1.00
CIT	-0.49	5.22
GSP	-0.86	4.07
TSP	0.03	1.00
OSHA 10-Hour for General Industry	-1.28	6.31
OSHA 10-Hour for Construction	-1.16	6.47
OSHA 30-Hour for General Industry	-1.17	6.56
OSHA 30-Hour for Construction	-1.00	7.09
CIH	0.03	1.00
Other	-1.21	7.36
Only On-the-Job Training	-1.39	5.44

Table 6 Summary Table of the Average Expected Scores and Average Normalized Score of Each Certification

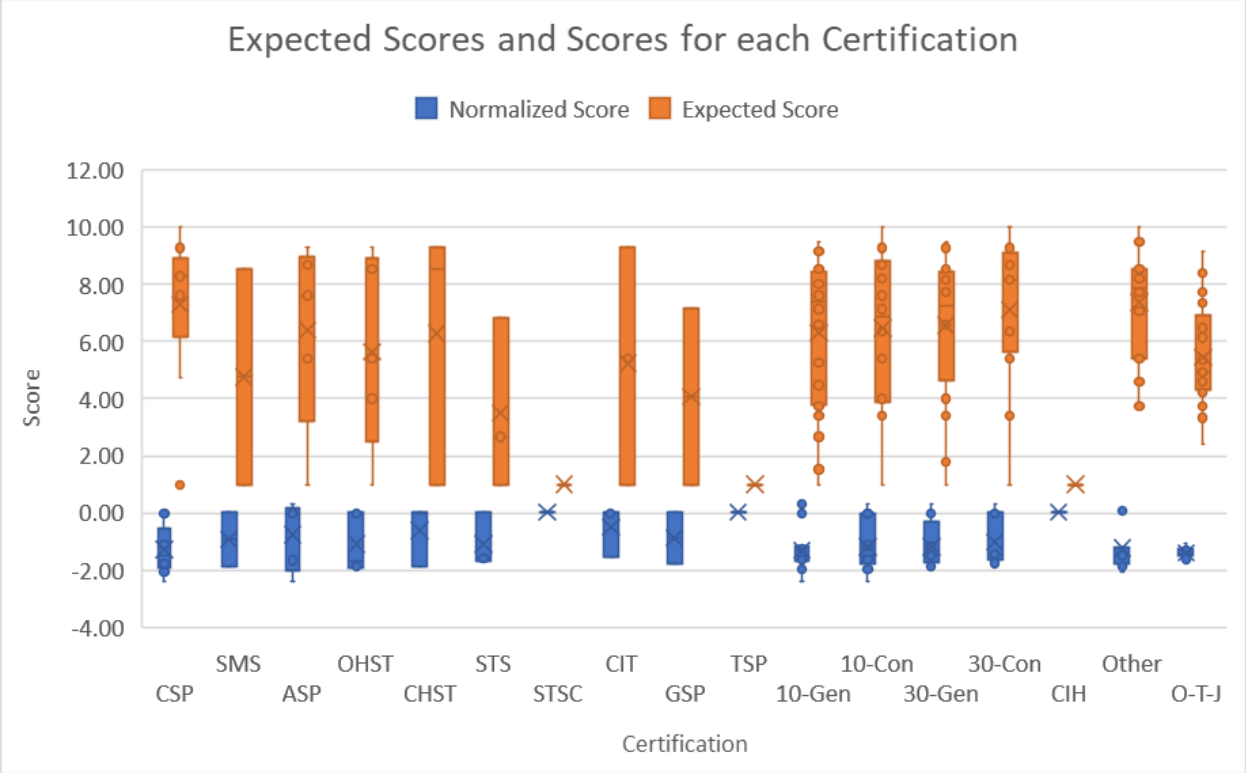

Figure 11 Box and Whisker Plot of the Expected Scores and Scores for each Certification

By analyzing the raw data as well as studying the graphs, we see that there is no statistical importance between how well people of any certification type actually performs compared to how well they think they will perform.

This study also took a look to see if there were any specific categories of safety in which individuals had a better understanding of hazard recognition. The tables of each individual's score and expected score for each certification can be found in Appendix C: Raw Data Tables.

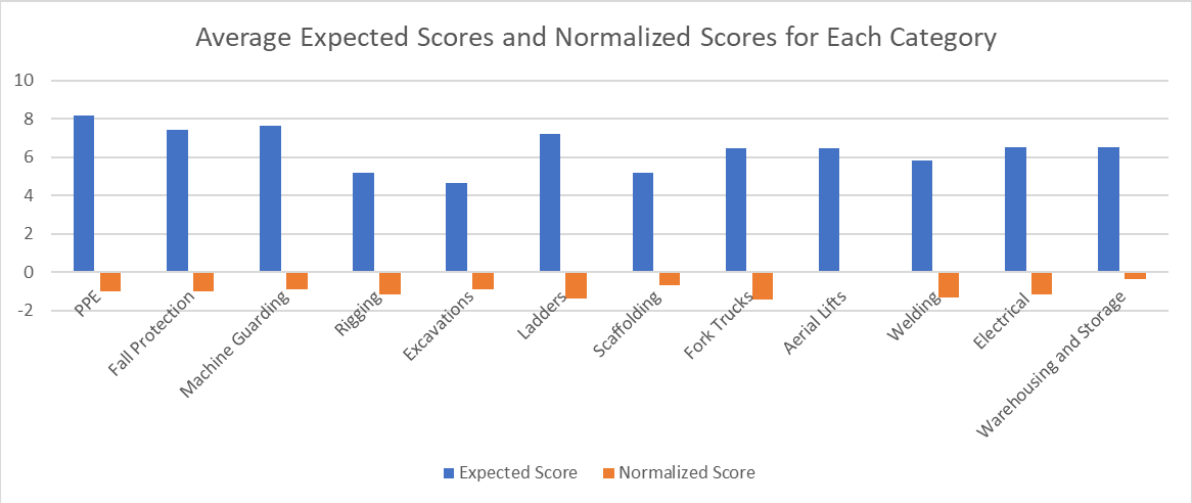

Figure 12 Bar Graph of Expected Scores and Normalized Scores for Each Category

Category	Average Expected Score	Average Normalized Score
PPE	8.16	-1.00
Fall Protection	7.43	-1.02
Machine Guarding	7.62	-0.89
Rigging	5.17	-1.18
Excavations	4.64	-0.87
Ladders	7.24	-1.36
Scaffolding	5.17	-0.68
Fork Trucks	6.46	-1.44
Aerial Lifts	6.44	0.07
Welding	5.80	-1.34
Electrical	6.51	-1.16
Warehousing and Storage	6.54	-0.37

Table 7 Summary Table of the Expected Scores and Normalized Scores of Each Category

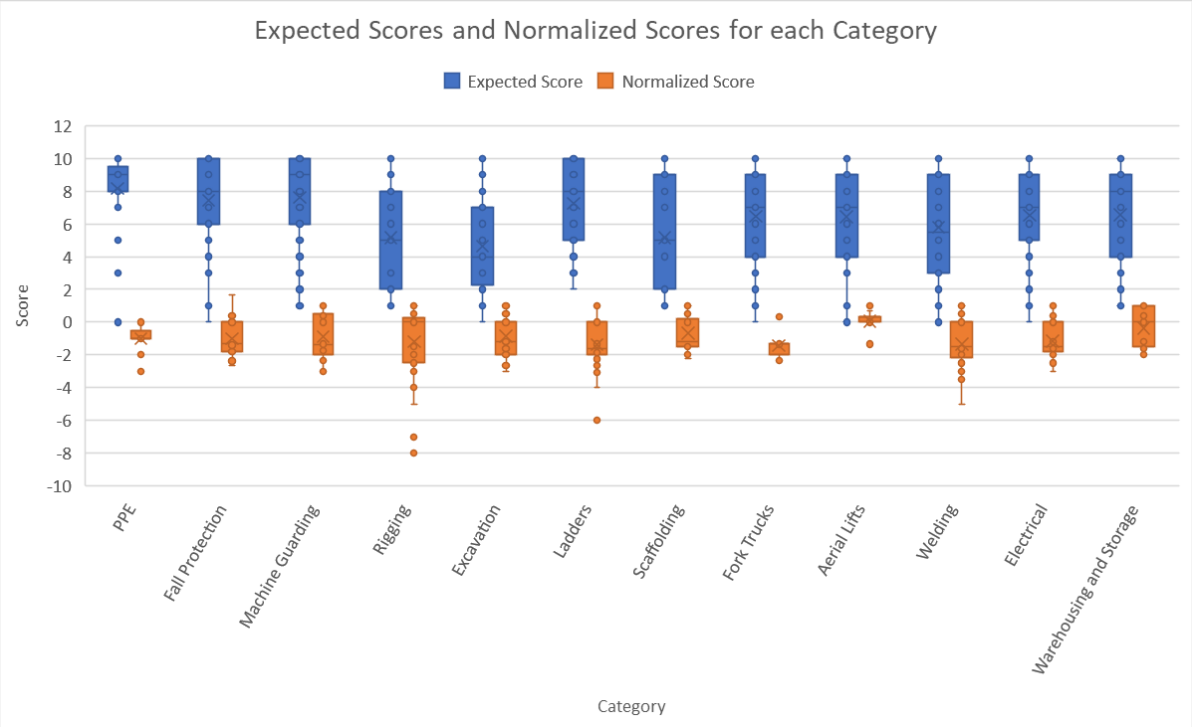

Figure 13 Box and Whisker Plot of the Expected Scores and Normalized Scores for each Category

Similar to the data about each certification type, there is no category that we tested that showed any type of statistical significance between how people thought they would do, and how they actually performed.

Based on the data collected from this study, it was found that there is a statistical significance between an individual's years of experience and their expected score. The longer that someone has worked in their industry, their perceived ability to identify hazards also increases. There is not enough data to determine if there is any significance between years of experience and normalized score or between one's expected score and their normalized score. This information is evident in the Pearson correlation analysis as well as the bar graphs and box and whisker plots that were created comparing individual's certifications vs. their normalized scores and their certifications vs. their expected scores.

It was also determined that there is no single certification type that better prepares individuals for identifying hazards. This is evident from the graphs that were plotted to compare the normalized scores and expected scores from all of the respondents of each certification category.

The last finding that the study found was that in each category being examined, individuals often overestimated their knowledge in the category and underperformed when asked to select the hazards from the images.

One theory that is believed to have caused the negative scores for the respondents is the Law of Instrument. This theory states that an evaluator's background directly relates to their evaluation choices. It is believed that, "once a researcher adopts an instrument or method into their methodological tool kit, it will often be applied in settings beyond its original intended purpose" [25]. If you only possess one tool, you will utilize that tool for everything. That is why this theory is also known as the Law of the Hammer. If you only have a hammer, everything is a nail. In this study, the respondents only had the tools in which their particular certifications provided them, and therefore could only correctly identify hazards based on what they already knew. However, when identifying hazards that they were not trained to identify they used their judgement which was based on what they actually knew. This pitfall caused the respondents to click on things that they thought were hazards which had no clear indication of being hazardous.

Conclusion

With thousands of workplace injuries and fatalities each year in the construction and manufacturing industries alone in the United States, there should be a large stress on the importance of workplace safety. Although these industries have made significant gains to keeping their employees safe, there will always be some risk associated with working these types

of jobs. It is very important that employees receive the necessary training to not only perform their jobs correctly, but also safely and to be able to recognize when a situation is hazardous. There should also be refresher courses for employees to remind them of potential hazards and how to respond to them. Through training and re-training, individuals should have the confidence, the competence, and the training to identify and prevent hazards and create safer workplace environments which will reduce the number of injuries and fatalities.

Recommendations for Future Research

We observed from these results that a cognitive bias, the Law of Instrument, may exist. This was observed by the number of hazards that were identified that were not evidently existent. The negative scores may have confounded the results. Accordingly, one recommendation for future research would be to develop a better method for the survey. We asked individuals to rank their confidence of how well they felt that they could identify hazards on a scale of 0-10. With this current scale, a negative ranking was not a possible option for respondents. It might be a consideration to include a post-test, where they would rank how they felt they did in identifying the hazards in the images that they actually were given.

There were a number of people who indicated very little experience but also did not indicate a complete ignorance of the subject. An examination on the ability to recognize hazards for people with little to no safety training may provide more insight into the effects that the Law of Instrument had as a confounding variable of this project.

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Appendix A: Institutional Review Board Approval Letter

December 15, 2020

Allen Johanson
Isaac Slaven
School of Technology

Dear Allen,

Thank you for submitting the research protocol titled, "The Importance of Safety Training in Identifying Workplace Safety Hazards: Examining the Dunning – Kruger Effect in Occupational Safety" for review by the Eastern Illinois University Institutional Review Board (IRB). The IRB has reviewed this research protocol and effective 12/15/2020, has certified this protocol meets the federal regulations exemption criteria for human subjects research. The protocol has been given the IRB number 20-143. You are approved to proceed with your study.

The classification of this protocol as exempt is valid only for the research activities and subjects described in the above named protocol. IRB policy requires that any proposed changes to this protocol must be reported to, and approved by, the IRB before being implemented. You are also required to inform the IRB immediately of any problems encountered that could adversely affect the health or welfare of the subjects in this study. Please contact me, or the Compliance Coordinator at 581-8576, in the event of an emergency. All correspondence should be sent to:

Institutional Review Board
c/o Office of Research and Sponsored Programs
Telephone: 217-581-8576
Fax: 217-581-7181
Email: eiuirb@eiu.edu

Thank you for your cooperation, and the best of success with your research.

John Bickford, Chairperson
Institutional Review Board
Telephone: 217-581-7881
Email: jbickford@eiu.edu

Appendix B: Survey

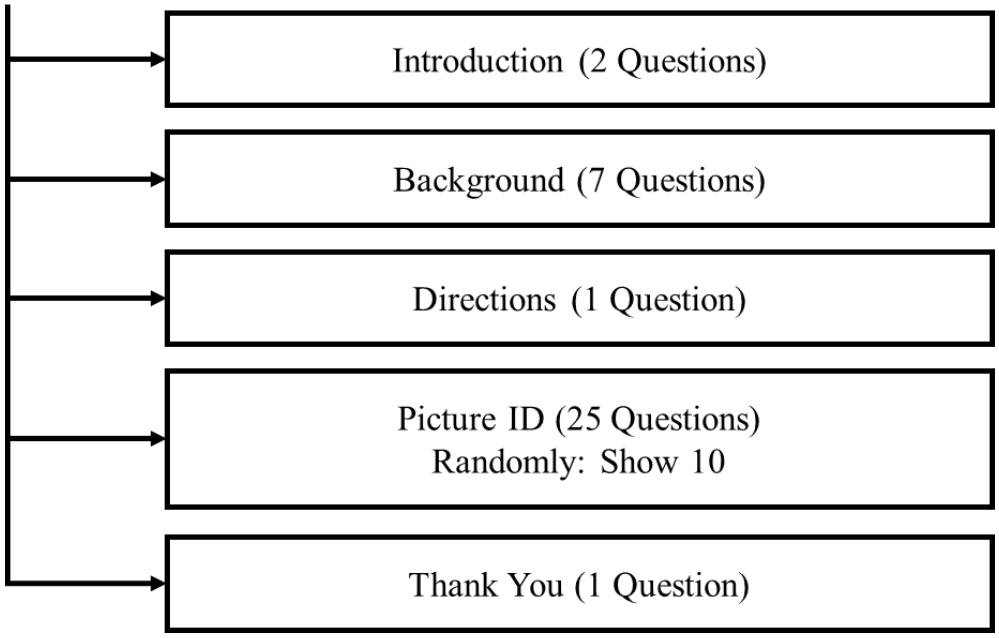


Figure 14 Survey Flow Chart

Hazard Identification

Hazard Identification Survey

Eastern Illinois University School of Technology invites you to take part in a brief survey about safety training and hazard recognition. The purpose of this survey is to research how confident people are in identifying workplace hazards based on any training they may have received.

Participating in this survey is completely voluntary. The decision to participate, decline, or withdraw from participation will have no effect on your future relations with EIU. This survey takes approximately 10-15 minutes.

Any information you share will be used in our analysis for aiding in identifying more effective ways to conduct safety training and creating safer work environments. Your identity and information will always be kept confidential and we maintain no information that could be able to potentially identify you as an individual.

Your input is important to us. We plan to use what we learn to help create safer work environments for workers in various industries.

Thank you for your participation in this survey.

If you have any questions or concerns about the treatment of human participants in this study, you may call or write:

Institutional Review Board
Eastern Illinois University
600 Lincoln Ave.
Charleston, IL 61920
Telephone: (217) 581-8576
E-mail: eiuirb@www.eiu.edu

You will be given the opportunity to discuss any questions about your rights as a research subject with a member of the IRB. The IRB is an independent committee composed of members of the University community, as well as lay members of the community not connected with EIU. The IRB has reviewed and approved this study.

How long (in years) have you worked in your specific industry?

_____

What is your current job position / title?

_____

Please check any training, certifications or degrees with respect to safety that you hold:

	Possess (current)	Outdated or Expired
Certified Safety Professional (CSP)	○	○
Safety Management Specialist (SMS)	○	○
Associate Safety Professional (ASP)	○	○
Occupational Health and Safety Technician (OHST)	○	○
Construction Health and Safety Technician (CHST)	○	○
Safety Trained Supervisor (STS)	○	○
Safety Trained Supervisor Construction (STSC)	○	○
Certified Instructional Trainer (CIT)	○	○
Graduate Safety Practitioner (GSP)	○	○
Transitional Safety Practitioner (TSP)	○	○
OSHA 10-Hour for General Industry	○	○
OSHA 10-Hour for Construction	○	○
OSHA 30-Hour for General Industry	○	○
OSHA 30-Hour for Construction	○	○
Certified Industrial Hygienist (CIH)	○	○
Other	○	○

Please check this box if the ONLY safety training you have received is on the job training (you haven't attended any other certification-based safety courses).

On The Job Training Only	○

If applicable, please List any other training, certifications or degrees with respect to safety that you have that were not mentioned above.

_____

Approximately what percentage of your job involves safety?

0	10	20	30	40	50	60	70	80	90	100
										

Rate your ability to identify hazards in the following:

	0 1 2 3 4 5 6 7 8 9 10
General Safety in Manufacturing	
General Safety in Construction	
Personal Protective Equipment (PPE)	
Fall Protection	
Lock Out - Tag Out	
Machine Guarding	
Rigging	
Excavations	
Ladders	
Scaffolding	
Fork Truck	
Aerial Lift	
Welding	
Electrical	
Warehousing and Storage	

Next, you will receive a series of 10 images. Please identify any hazards that you see within the picture by clicking on the hazard. If you do not see any hazards, just move on to the next picture.

Click on any hazards you see in the picture

Click on any hazards you see in the picture

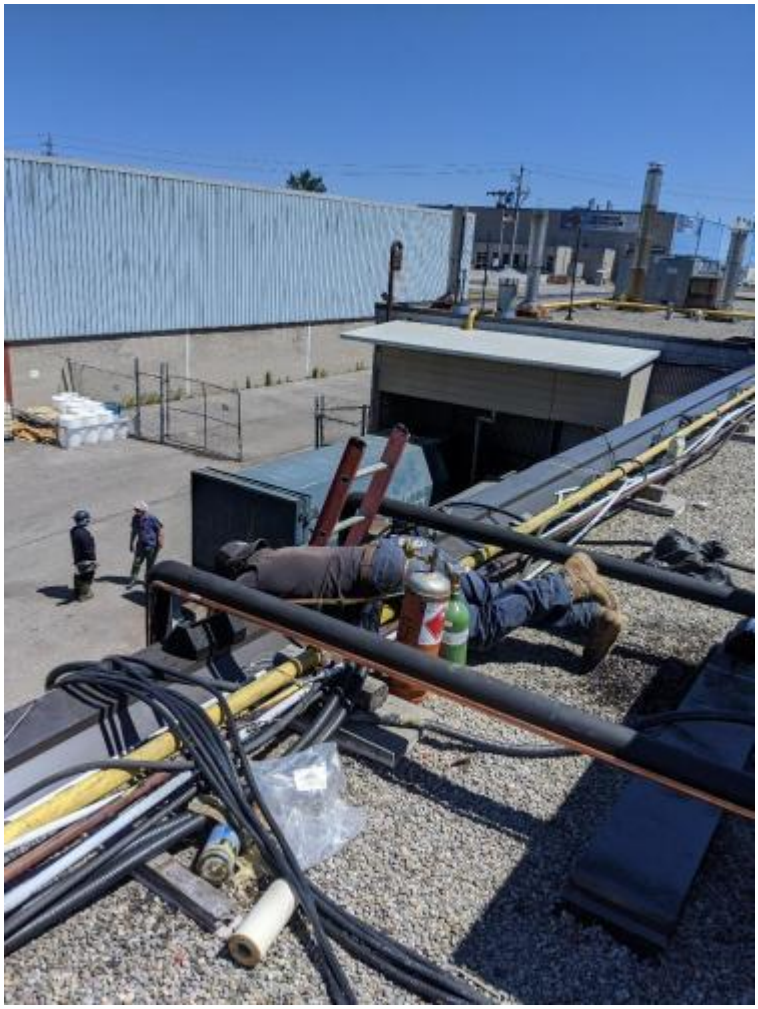
Click on any hazards you see in the picture

Click on any hazards you see in the picture

Click on any hazards you see in the picture

Click on any hazards you see in the picture

Click on any hazards you see in the picture



Click on any hazards you see in the picture

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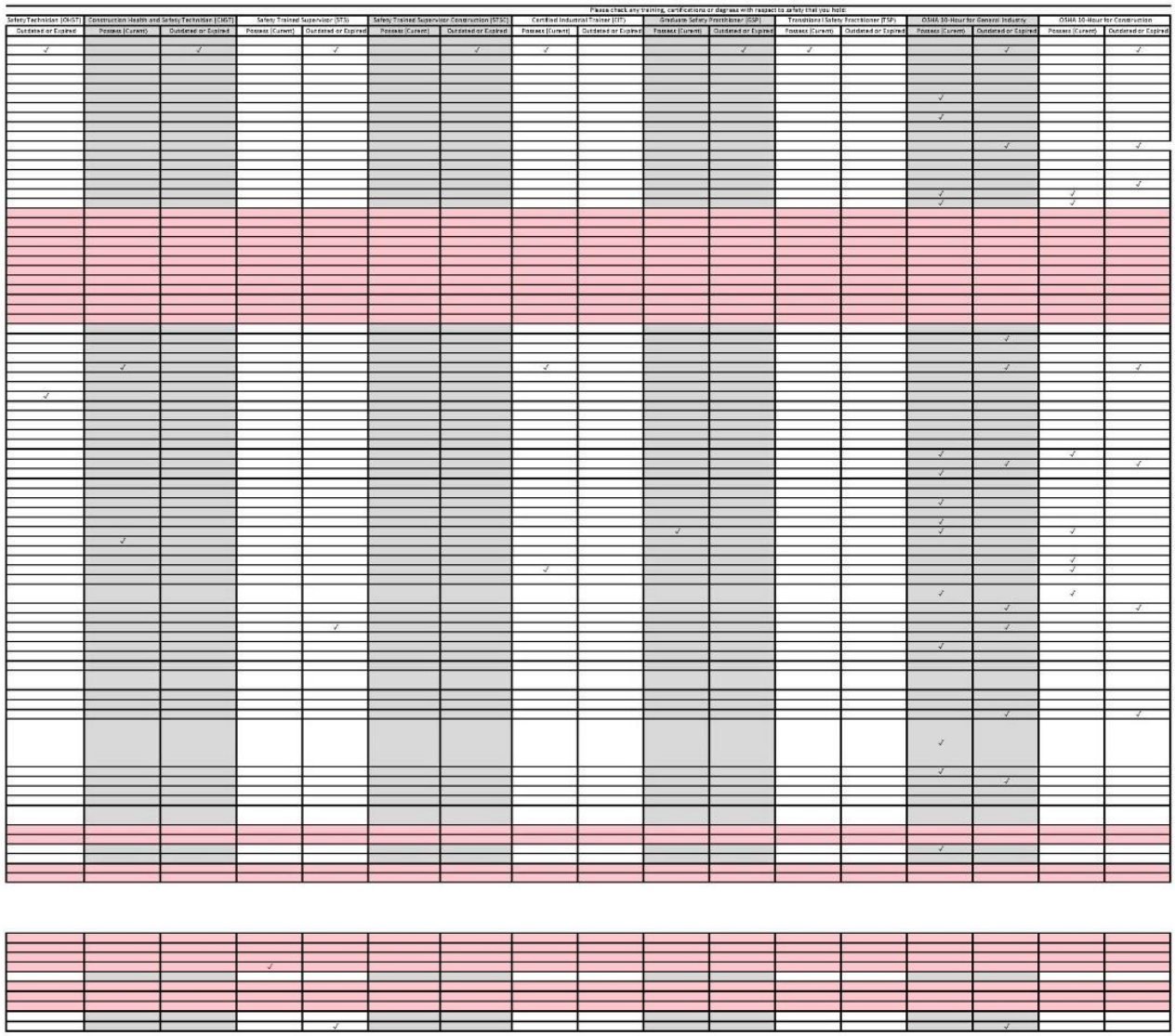
Click on any hazards you see in the picture

Thank you for your participation in this survey. Your response is greatly appreciated.

Appendix C: Raw Data Tables

	Response ID	Recorded Date	How many years during your career have been spent in a job where safety or EHS (Environmental Health and Safety) related responsibilities were a significant component?	What is your current job position / title?	Certified Safety Professional (CSP)		Safety Management Specialist (SMS)		Associate Safety Professional (ASP)		Occupational Health and
					Possess (Current)	Outdated or Expired	Possess (Current)	Outdated or Expired	Possess (Current)	Outdated or Expired	Possess (Current)
1	R_1dEXahgDwKBVyVDP	2/23/2023 1:35	5	Professor							
2	R_3iHUIFPkdiNEqq8	2/23/2023 5:57	15	Professor of Simulation, Animation, and Gaming		✓		✓		✓	
3	R_3YGBrYuJEAzlx7I	2/23/2023 8:25	9	Associate Professor							
4	R_3IWTSOrWEITY3	2/23/2023 6:46	42	Associate Dean							
5	R_4VnWnRRaqDNRu	2/23/2023 7:09	12	Chair, McCoy School of Engineering							
6	R_5HwqfZAzkZP2Fl	2/23/2023 7:23	3	Professor							
7	R_6D6VIKfnsIm25A3L	2/23/2023 7:22	5	Faculty, Manufacturing							
8	R_7FdbNALZCOQcn9	2/23/2023 7:45	40	Professor							
9	R_7QBgjV3QvBE3Efe	2/23/2023 8:05	35	Director of engineering science and mechanical technologies							
10	R_7dlTBvs3YTWwZVdo	2/23/2023 8:05	35	Engineering and Technology Director of an academic program in manufacturing							
11	R_7x1FPJ5VGBrc2XM	2/23/2023 8:09	40	Professor							
12	R_8BGpfIOzyXUTaaE	2/23/2023 8:23	30	Engineering/STEM Program Director, Engineering Department at large Community College							
13	R_8Ej3nmXgaxUWstI	2/23/2023 11:48	1	Professor							
14	R_9nTmn21MdRfRNI	2/23/2023 13:08	30	Professor							
15	R_9SQEbXcbsVVuNd	2/23/2023 17:06	12	Teacher							
16	R_9dNZPhVGwnSeh9	2/25/2023 10:31	5	Professor							
17	R_9kgnV91dVxzbd	3/1/2023 8:38	2	Manufacturing Engineer							✓
18	R_9tegSEOVELxRDvz	3/1/2023 12:52	0	-							
19	R_aOHECDmLLbMFVu	3/2/2023 2:35	-	-							
20	R_a8n2S9BGggrIbAR	3/2/2023 3:58	-	-							
21	R_aJyDzyZIM1DJDjj	3/2/2023 5:35	10	Associate Professor, Mechanical Engineering Technology							
22	R_aVKeLmeEKGuA1T	3/2/2023 5:53	40	-							
23	R_aCpAVKBwFvKCTy	3/2/2023 7:34	-	-							
24	R_aXHOHdrgAV2M2SL	3/2/2023 9:31	4	Director							
25	R_aOWABJoy6XorwQF	3/2/2023 10:03	-	-							
26	R_aUnIPmAJrPuJapVP	3/2/2023 10:25	-	-							
27	R_aJuzBQgCBTpzYH	3/2/2023 11:26	-	Instructor							
28	R_b2DcMzRBeTY1u	3/3/2023 8:35	20	-							
29	R_b2YCYzjgVC+tOWQ	3/3/2023 9:44	34	Adjunct Professor, Biomedical Engineering Technology							
30	R_bnTbvWUJzI7Jf	3/6/2023 10:51	-	-							
31	R_bUGaAGWaSrUi3	3/8/2023 10:53	5	High School Teacher							
32	R_bpxhYWJGPTLZSC9	3/13/2023 8:56	13	Continuous Improvement Manager							
33	R_bwPscnyyBEDtnxf	3/13/2023 9:05	30	Maintenance Planner							
34	R_bDYHSkMTvCKoXvH	3/13/2023 9:33	25	production supervisor							
35	R_bHJ7JWVUp3ateEf	3/13/2023 9:20	37	consultant	✓					✓	✓
36	R_bLzJnuKc8CouNj	3/13/2023 9:25	17	Health/Safety and Warehouse Manager							
37	R_bUEGkPqHbrAUVM	3/13/2023 9:38	25	Training Coordinator							
38	R_bnXE0qq2nuEVTod	3/13/2023 9:43	25	President / Senior Loss Control Consultant						✓	
39	R_bpEHYadaSePRjtw	3/13/2023 14:33	15	Professor							
40	R_bu5eRJGGnEIPk	3/13/2023 15:03	17	ET Lab Supervisor	✓						
41	R_1C1PMJCHnBGr5	3/13/2023 17:30	8	Professor							
42	R_1JEPK8NlenetUu7v	3/13/2023 18:38	18	Pre mete ready lead							
43	R_1BucQ3pXK1Cbm9V	3/13/2023 5:02	23	Human Resource Manager							
44	R_1CNrRRQprQaFX1S	3/13/2023 13:28	5	Fabrication Department Manager							
45	R_1EaHjvLuDNOaJ9	3/13/2023 10:35	23	Risk Control Consultant					✓		
46	R_1qdDqMwTVptnnnt	3/13/2023 10:30	35	Safety Manager							
47	R_1pLYEgp3dQWI3C2	3/13/2023 11:37	38	Assistant Vice President							
48	R_1EnmAJKJC+XWmy	3/13/2023 11:43	40	Retired							
49	R_1OJfmYaTyD0Eayl	3/13/2023 13:03	0	Operations Manager							
50	R_1RA4v75hdbFCrJix	3/13/2023 13:40	19	Production Manager							
51	R_1TrRhCFH5aa3NDl	3/13/2023 13:52	18	Safety Director							
52	R_1Xm16GJRnOmshj	3/13/2023 14:37	35	Associate Loss Control Consultant							
53	R_1CgatvWJaTFVqwT	3/13/2023 16:42	43	VP of Health & Safety			✓				✓
54	R_1GoAjEpJQwJgtQ	3/13/2023 14:57	35	Chief Risk Officer	✓						
55	R_1dkM2rp55qgERK9	3/13/2023 15:32	46	Owner/President	✓						
56	R_1tr2LCaDwRDEqn	3/13/2023 16:03	6	Safety and Health Consultant							
57	R_1bEdBP35dwW39lr	3/13/2023 19:08	35	Retired-Associate Loss Consultant							
58	R_1RJnJx5vgEZJUfT	3/13/2023 19:22	25	Instructor							
59	R_2Y9CIbkAEXiYYJbD	3/13/2023 19:48	30	Safety Consultant, Ret		✓				✓	
60	R_2mEhyUEXW91JLx	3/16/2023 7:38	9	Mechanical Engineer							
61	R_2Ebxn2O6oN45KR	3/16/2023 7:32	20	Supplier Quality Supervisor							
62	R_2n7hCWJPCbEDWv	3/16/2023 7:30	8	Manufacturing Engineer							
63	R_2Z4HOwq2ZgrBFML	3/16/2023 7:22	17	Vice President of Risk Control							
64	R_2UBTbeWtcFMEBEO	3/16/2023 7:32	7	Manufacturing Engineer							
65	R_2kpCBF5OmPbeVUg	3/16/2023 8:48	16	Engineering Team Leader							
66	R_vUe5OL9ETp0WY62	3/16/2023 9:23	10	Loss Control Consultant							
67	R_3kxKLsz3crKcITA	3/16/2023 10:02	12	Plant Manager							
68	R_3OnSEwESM9OnLI	3/16/2023 10:03	12	EHS Leader	✓						
69	R_2r2CJJAwuyuYJ	3/16/2023 14:23	15	Vice President of Risk Management							
70	R_3D3QHyd9KUW7rHn5	3/16/2023 16:40	23	Independent Safety Consultant/Risk Management Consultant							
71	R_3dHvKRTDHwb3H	3/16/2023 15:58	23	National Safety Consultant	✓						
72	R_3gLTBNFaM+Zdth+	3/16/2023 18:09	25	Vice President Employee Services							
73	R_3H7wjEpqthi7NJH	3/17/2023 7:40	25	Director of Engineering							
74	R_3CooSNZEtZC1ZhS	3/17/2023 7:40	17	Machining Manufacturing Engineer							
75	R_3TMaDk3dpaCBrDI	3/17/2023 12:08	27	Engineering Manager							
76	R_3PJaWgFVnJmrQI0	3/18/2023 9:32									
77	R_3F8YWUnDHFT94o	3/18/2023 10:28	25	Supervisor							
78	R_3FdFkpOHJuuID	3/18/2023 11:38	20	VP Risk Control							
79	R_3bfqiQusKJ9Kk5	3/21/2023 8:27	28	Area Manager - Sr. Risk Control Consultant							
80	R_3wwfmtYEyBuCh	3/22/2023 9:57									
81	R_3hwIdtdgNHnr8E	3/23/2023 13:40									

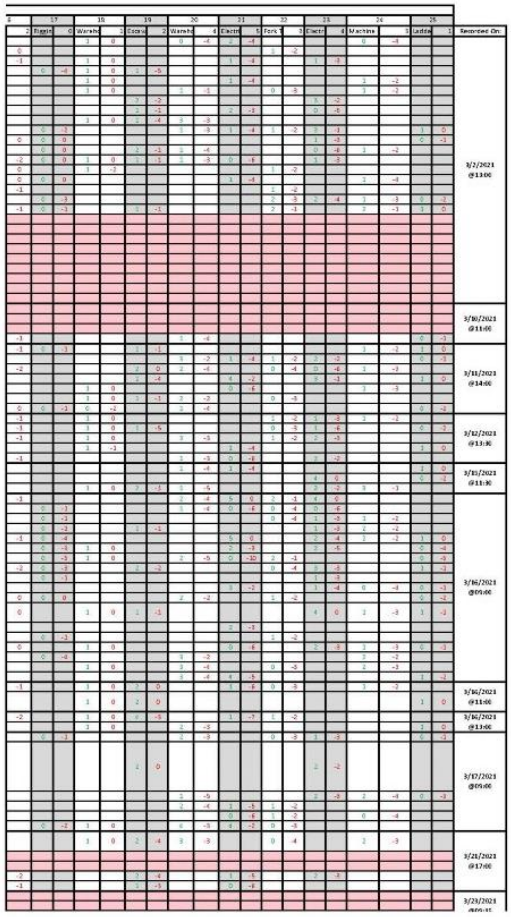
82	R_3PsuIRxm12mHM	3/23/2023 7:12	0	Risk Control Coordinator							
83	R_3JEWJNgRckcSI	3/23/2023 8:40									
84	R_3CS7DNnna2HrSDI	3/23/2023 10:29									
85	R_3n3arBMM3Gu2fl	3/23/2023 11:32	12	Training Manager							
86	R_3UaECDvGEB3Ky7	3/23/2023 13:29	40	Senior Vice President- Risk Control Services	✓						
87	R_3ld3S2IBEfpjtcr	3/23/2023 15:58									
88	R_3DJHHqXcwy5hnA	3/24/2023 11:30	0	VP- Risk Control							
89	R_3pc2AsWKTJFNkE	3/25/2023 7:33									
90	R_3baaYabnQaDnnn	3/26/2023 13:34	42	Maintenance Team Leader							
91	R_3T2WkpeaQ9kL	3/29/2023 23:09	29	Print Supervisor							

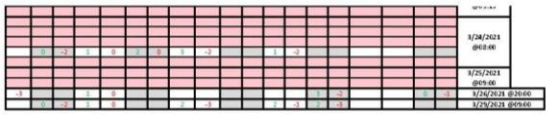

Please check any training, certifications or degrees with respect to safety that you hold:
Safety Technician (OHST)
Construction Health and Safety Technician (CHST)
Safety Trained Supervisor (STS)
Safety Trained Supervisor Construction (STSC)
Certified Industrial Trainer (CIT)
Graduate Safety Practitioner (GSP)
Transitional Safety Practitioner (TSP)
OSHA 30-Hour for General Industry
OSHA 10-Hour for Construction
Outdated or Expired
Possess (Current)
Outdated or Expired
Possess (Current)
Outdated or Expired
Possess (Current)
Outdated or Expired
Possess (Current)
Outdated or Expired
Possess (Current)
Outdated or Expired
Possess (Current)
Outdated or Expired
Possess (Current)
Outdated or Expired
Possess (Current)
Outdated or Expired

OSHA 30-Hour for General Industry		OSHA 30-Hour for Construction		Certified Industrial Hygienist (CIH)		Other			Only On-the-Job Training	Approximately what percentage of your job involves safety?	Rate your ability to identify hazards in the following:			
Possess (Current)	Outdated or Expired	Possess (Current)	Outdated or Expired	Possess (Current)	Outdated or Expired	Certification	Possess (Current)	Outdated or Expired			General Safety in Manufacturing	General Safety in Construction	Personal Protective Equipment (PPE)	Fall Protection
										30	5	8	4	3
	✓		✓		✓					35	3	3	3	0
									✓	35	9	8	9	7
						Minor in Safety Education				25	10	10	10	10
	✓									20	-	5	-	-
										-	6	6	8	4
✓						OSHA 500 or 508	✓			30	10	10	10	10
									✓	20	8	8	5	7
										21	10	7	9	9
						NIMS	✓			1	10	10	10	10
									✓	20	9	-	3	3
	✓		✓			HAZWOPP / HAZWOPP Supervisor		✓		80	8	9	9	9
										5	6	2	9	9
									✓	30	6	7	9	7
									✓	100	10	8	10	10
		✓								20	4	9	9	7
✓										90	7	4	10	9
										8	7	3	9	4
										-				
										-				
									✓	90				
										-				
										-				
										-				
										-				
										-				
										-				
										-				
										-				
									✓	17	8	8	7	8
										11	7	4	8	6
									✓	30	10	7	10	10
									✓	20	7	7	9	9
	✓		✓							83	9	9	9	10
									✓	80	6	2	7	7
										21	7	6	9	6
						BS Occupational Safety				100	9	-	9	9
									✓	5	-	-	5	8
						OSI Training				90	10	8	10	10
									✓	40	7	5	10	8
									✓	30	7	5	7	7
										30	5	-	8	1
✓		✓								33	2	9	7	7
	✓		✓			Associate of Risk Management				100	10	8	10	8
		✓								86	9	9	10	10
						Ergonomics Certification				90	9	9	9	8
✓										75	8	4	7	6
										30	1	1	5	1
									✓	5	8	1	8	9
										75	10	5	10	10
										100	10	10	10	8
						RSO, Teaflest				98	7	9	9	9
						Associate in Risk Management (ARM)				80	8	8	8	9
		✓				BS Occupational S&H				88	10	10	10	10
		✓								45	5	9	9	9
						ARM			✓	99	2	2	7	8
✓		✓				OSHA Outreach Trainer, BS & MS Safety Management				80	10	10	10	10
										100	10	10	10	8
	✓									80	8	8	9	7
										20	8	4	8	5
									✓	20	7	5	9	10
									✓	100	10	10	10	10
									✓	5	9	8	8	5
									✓	1	7	4	6	8
						Master Safety Professional, OSHA authorized instructor	✓			40	10	-	10	10
									✓	30	9	7	9	7
										100	10	10	10	10
	✓		✓							100	5	5	9	2
✓						OSHA Outreach "Train the Trainer" for Respiratory Protection, Fall Protection & Powered Industrial Trucks; Virginia Tech University Certified "Train the Trainer" for Fall Protection & Hazard Communication				80	8	7	9	10
✓						BS Occupational Safety, OSHA 501				100	10	8	10	10
						Monthly safety training at company				20	8	2	8	9
										30	8	4	8	5
									✓	83	8	6	9	9
						Monthly training across multiple safety programs such as LOTO, SDS, Fire			✓	1	8	1	9	7
	✓		✓							75	8	7	9	8
										100	10	-	10	-

✓						NCCER Instructor				70	8	10	9	9
										99	10	8	10	9
						LO/TO and Arc Flash				20	10	5	10	10
	✓									80	9	7	9	8

Lock Out - Tag Out	Machine Guarding	Rigging	Excavations	Ladders	Scaffolding	Fork Trucks	Aerial Lifts	Welding	Electrical	Warehousing and Storage
5	7	6	7	7	6	7	7	7	6	7
2	-	-	-	-	-	-	-	2	2	-
6	8	6	8	9	6	6	7	7	6	7
10	10	8	8	10	10	10	10	10	10	10
2	3	-	-	5	-	-	-	-	5	5
4	3	8	8	5	5	4	4	6	8	6
10	10	7	-	10	6	10	10	-	6	10
8	8	1	1	6	4	3	-	6	1	6
9	9	8	8	8	8	5	2	6	8	8
10	9	9	8	9	1	10	8	7	7	9
10	10	8	0	5	1	10	0	0	10	0
9	8	7	10	10	9	8	8	7	8	8
8	8	1	1	8	8	0	-	1	9	1
9	9	2	1	2	2	5	0	9	9	4
10	10	7	-	10	10	5	-	10	10	-
5	0	8	9	10	9	8	8	7	8	7
7	9	-	-	5	-	7	-	3	-	5
5	7	1	1	5	1	1	1	6	1	2
9	8	1	1	8	2	7	8	9	6	1
7	5	2	1	3	2	6	5	3	1	7
10	6	4	0	8	10	10	10	9	2	5
9	9	5	5	9	7	7	7	1	5	5
10	9	10	10	10	10	9	9	7	9	9
8	6	5	2	6	1	5	5	0	0	5
6	6	1	1	8	-	8	6	-	3	-
8	9	-	4	8	2	8	4	5	3	8
6	7	2	-	5	-	-	-	2	5	-
10	10	-	-	10	10	10	10	-	10	10
10	10	5	0	5	-	0	-	-	7	-
7	7	-	-	5	-	5	-	-	-	-
3	1	-	-	-	-	-	-	-	-	-
5	2	10	10	7	4	7	7	10	10	2
10	10	5	6	10	8	10	9	8	8	10
10	10	6	5	10	5	10	8	9	6	10
10	9	9	5	8	2	9	8	5	8	9
7	7	6	6	7	7	9	9	5	4	9
3	1	-	-	4	1	1	-	-	1	2
5	8	3	1	8	1	7	2	2	1	5
10	10	5	5	5	5	10	10	5	10	10
10	10		6	10	4	10	4	-	4	9
9	9	8	9	9	8	9	9	9	7	8
8	8	2	8	8	4	8	2	2	2	4
10	10	10	10	10	10	10	10	10	10	10
6	6	4	8	9	4	3	3	3	2	2
8	8	1	-	7	5	2	1	0	2	5
10	10	8	8	10	10	10	10	8	8	10
8	8	-	7	10	10	7	-	7	10	9
9	9	8	1	8	1	8	8	8	9	8
5	5					5		0	1	
10	10	6	6	7	10	7	10	10	9	10
10	10	5	5	10	7	10	10	10	10	10
9	8	2	2	9	1	7	8	9	8	8
8	8	8	8	8	4	8	8	8	8	8
10	10	2	-	10	8	10	10	9	8	8
9	8	8	8	8	4	8	2	2	8	6
10	10	8	8	10	4	10	10	8	8	9
4	3	-	-	8	-	7	-	-	-	10
10	7	8	4	10	4	10	10	8	7	10
10	10	8	8	10	8	10	10	8	8	9
8	8	1	1	6	2	6	6	2	8	8
9	9	1	0	8	-	8	8	1	8	1
10	10	8	8	9	8	8	8	7	7	8
9	9	2	8	8	3	8	1	0	8	3
10	10	8	7	7	7	10	8	7	7	9
10	10	-	-	10	-	10	-	-	-	10
10	10	10	10	10	8	10	10	7	7	9
10	10	8	7	8	8	10	7	10	7	10
10	10	9	9	9	9	9	9	9	9	8
9	9	8	8	8	8	8	8	8	7	7


Recorded On
3/2/2021 @13:00
3/10/2021 @11:00
3/11/2021 @14:00
3/12/2021 @13:30
3/15/2021 @11:30
3/16/2021 @09:00
3/16/2021 @11:00
3/16/2021 @13:00
3/17/2021 @09:00
3/21/2021 @17:00
3/23/2021


3/24/2021 @18:00
3/25/2021 @09:00
3/26/2021 @20:00
3/29/2021 @09:00

CSP	
Score	*Expected Average*
0.00	9.27
-2.05	7.87
-1.75	4.73
-1.58	10.00
-1.09	8.27
-1.48	8.53
-1.10	8.47
0.03	1.00
-2.38	7.60
-1.27	***7.30***

SMS	
Score	*Expected Average*
-1.87	8.53
0.03	1.00
-0.92	***4.77***

ASP	
Score	*Expected Average*
0.32	8.67
0.03	1.00
0.00	9.27
-1.65	5.40
-2.38	7.60
-0.74	***6.39***

OHST	
Score	*Expected Average*
-1.95	4.00
0.00	9.27
-1.87	8.53
0.03	1.00
-1.65	5.40
-1.09	***5.64***

CHST	
Score	*Expected Average*
0.00	9.27
-1.87	8.53
0.03	1.00
-0.61	***6.27***

STS	
Score	*Expected Average*
0.03	1.00
-1.59	2.67
-1.68	6.80
-1.08	***3.49***

STSC	
Score	*Expected Average*
0.03	1.00
0.03	***1.00***

CIT	
Score	*Expected Average*
0.03	1.00
0.00	9.27
-1.52	5.40
-0.49	***5.22***

GSP	
Score	*Expected Average*
-1.76	7.13
0.03	1.00
-0.86	***4.07***

TSP	
Score	*Expected Average*
0.03	1.00
0.03	***1.00***

OSHA 10-General	
Score	*Expected Average*
-1.41	7.87
-1.50	5.27
-1.95	4.00
-1.13	3.53
-1.42	6.60
-1.26	8.67
-1.42	1.53
-1.14	8.00
-1.76	7.13
0.08	9.47
-1.52	9.13
-1.17	7.73
-1.48	8.53
-1.74	8.13
0.03	1.00
-1.86	8.20
-1.43	4.47
0.00	9.27
0.32	8.67
-2.38	7.60
-1.59	2.67
-1.63	3.40
-1.69	3.73
-1.68	6.80
-1.28	***6.31***

OSHA 10-Hour Construction	
Score	*Expected Average*
-1.95	4.00
-1.13	3.53
-1.42	6.60
-1.76	7.13
-1.58	10.00
-1.52	5.40
0.08	9.47
0.03	1.00
-1.86	8.20
-1.48	6.33
0.00	9.27
0.32	8.67
-2.38	7.60
-1.63	3.40
-1.16	***6.47***

OSHA 30-Hour General	
Score	*Expected Average*
-1.41	7.87
-1.95	4.00
-1.42	6.60
-1.80	6.67
0.08	9.47
-1.17	7.73
-1.48	8.53
0.03	1.00
-1.48	1.80
-1.86	8.20
0.00	9.27
0.32	8.67
-1.57	6.80
-1.63	3.40
-1.74	8.13
-1.68	6.80
-1.17	***6.56***

OSHA 30-Hour Construction	
Score	*Expected Average*
-1.48	6.33
-1.42	6.60
-1.26	8.67
-1.58	10.00
-1.52	5.40
0.08	9.47
0.03	1.00
-1.86	8.20
0.00	9.27
0.32	8.67
-1.63	3.40
-1.74	8.13
-1.00	***7.09***

CIH	
Score	*Expected Average*
0.03	1.00
0.03	***1.00***

Other	
Score	*Expected Average*
-1.81	9.73
-1.41	7.87
-1.23	8.40
-1.86	8.20
-1.65	5.40
-2.05	7.87
0.32	8.67
0.28	7.27
-1.87	8.53
-1.75	4.73
-1.58	10.00
-1.48	3.73
0.08	9.47
0.16	7.07
-1.17	7.73
-1.48	8.53
-1.69	3.73
-1.46	4.60
-1.32	8.40
-1.21	***7.36***

Only On-the-Job	
Score	*Expected Average*
-1.48	4.80
-1.45	4.27
-1.25	4.47
-1.28	5.40
-1.21	7.33
-1.60	6.13
-1.35	7.40
-1.58	6.47
-1.24	4.20
-1.31	2.40
-1.07	4.33
-1.23	3.33
-1.35	4.40
-1.48	3.73
-1.45	8.40
-1.52	9.13
-1.50	5.53
-1.48	4.93
-1.71	5.33
-1.22	7.73
-1.46	4.60
-1.39	***5.44***

Personal Protectice Equipment (PPE)	
Expected Score	*Score*
10	-3.00
5	-1.00
9	-1.00
3	-1.00
9	-2.00
0	0.00
10	-2.00
8	0.00
9	-1.00
9	-1.00
7	-1.00
9	-1.00
10	-1.00
7	-1.00
8	-1.00
10	-2.00
9	0.00
9	-1.00
10	-1.00
10	-1.00
9	-1.00
9	0.00
8	0.00
8	0.00
9	-2.00
8.16	**-1.00**

Fall Protection	
Expected Score	*Score*
4	-2.00
0	0.20
10	0.00
10	0.40
7	-2.00
3	-1.80
7	-1.20
8	-2.38
7	0.00
7	-2.00
1	-1.60
7	-1.25
8	0.00
10	-2.67
8	0.00
6	-1.38
5	0.33
10	-1.50
9	1.67
10	-1.38
9	-1.63
10	-1.13
7	-1.80
10	0.00
10	-1.67
5	-2.33
6	-1.63
10	-1.13
7	-1.13
10	0.00
10	-2.33
5	0.13
7	0.20
9	-1.33
8	-1.40
7.43	**-1.02**

Machine Guarding	
Expected Score	*Score*
6	-2.33
8	-2.00
5	-1.40
3	0.20
10	0.00
9	1.00
10	1.00
6	-1.75
6	-2.00
10	-1.50
9	-1.67
7	0.50
6	-2.00
5	-1.33
9	-1.67
6	-1.50
6	-2.00
9	0.50
7	-1.33
10	-2.00
7	-2.00
1	-3.00
2	0.00
10	1.00
10	0.50
9	1.00
1	0.40
8	-1.25
10	0.25
9	-2.00
6	-3.00
4	-2.33
6	1.00
10	-1.67
8	-3.00
9	0.00
5	-1.60
10	-1.50
10	-1.33
6	-1.33
10	1.00
8	-2.00
10	0.00
7	1.00
10	-1.67
4	-2.00
9	-2.33
10	1.00
9	-2.00
10	1.00
10	1.00
10	1.00
9	-2.00
7.62	**-0.89**

Rigging	
Expected Score	*Score*
6	0.00
8	-2.33
7	1.00
1	-1.33
9	-1.50
8	1.00
7	0.00
2	0.00
6	0.00
1	0.00
2	0.00
3	-3.00
10	1.00
3	0.50
1	0.33
3	0.00
10	-2.00
5	0.50
6	0.00
8	-5.00
2	-4.00
10	0.00
1	-3.00
8	0.00
6	-2.50
5	1.00
2	-4.00
2	0.00
5	0.50
5	0.00
5	0.00
1	0.50
6	-7.00
5	-3.00
9	-2.00
8	-8.00
5.17	**-1.18**

Excavation	
Expected Score	*Score*
7	-2.00
3	-2.00
8	-1.80
3	-1.33
1	-1.20
3	-2.00
10	0.50
1	0.00
9	-3.00
1	-1.60
1	0.00
3	1.00
10	-2.50
1	-1.20
4	-1.67
0	0.33
6	0.00
5	0.50
1	-1.20
6	-1.33
9	0.00
3	0.00
8	-2.00
8	0.00
7	-2.67
5	0.00
2	-1.67
3	0.00
3	0.50
4	-1.20
4	0.00
1	-1.33
5	0.67
8	-2.00
7	-2.00
7	1.00
4.64	**-0.87**

Ladders	
Expected Score	*Score*
7	-2.00
9	-2.00
10	-2.50
5	-1.64
5	-2.00
10	-4.00
4	0.14
3	1.00
8	-1.33
3	-1.50
8	1.00
2	-2.00
10	1.00
10	-1.88
5	-3.00
3	-1.50
8	-1.50
3	-1.67
8	-1.91
10	0.00
6	1.00
8	-1.86
8	-1.88
5	-1.50
10	-3.00
5	1.00
7	-1.50
10	0.25
10	0.00
8	-1.75
7	-1.33
4	-1.33
3	-1.71
5	1.00
10	-2.13
9	-6.00
4	0.00
10	-1.91
9	-2.25
7	-2.50
10	0.00
10	-3.09
8	-1.63
7	-2.67
5	-2.00
10	1.00
10	0.11
6	-1.88
10	-1.60
8	-1.56
4	-1.55
8	-1.25
7	-2.40
10	0.00
9	-1.75
7.24	**-1.36**

Scaffolding	
Expected Score	*Score*
5	0.00
4	-1.50
1	1.00
9	-2.25
8	-2.00
2	0.17
10	0.50
9	-1.33
1	0.00
2	0.00
2	-1.33
10	-1.25
7	-1.50
1	-1.25
2	1.00
10	-1.17
5	0.25
2	0.50
1	-2.00
5	-1.17
4	-1.50
10	-1.50
5	1.00
10	1.00
1	-1.25
4	0.00
4	-1.50
7	0.17
9	-1.67
5	-1.75
5.17	**-0.68**

Fork Trucks	
Expected Score	*Score*
4	-2.00
10	-1.33
5	-1.33
8	-1.33
7	-1.33
3	0.33
10	-1.33
7	-2.33
8	-2.00
10	-2.00
0	-1.33
9	0.33
9	-2.33
1	-2.33
9	0.33
6	-2.33
2	-1.33
8	-1.33
10	-2.00
5	-2.00
3	-1.33
7	-2.00
4	-1.33
7	-1.33
8	-2.00
3	-2.33
10	-1.33
8	0.33
6.46	**-1.44**

Aerial Lifts	
Expected Score	*Score*
0	-1.33
4	-1.33
8	0.33
0	1.00
8	1.00
10	0.00
7	1.00
9	0.33
5	0.33
7	0.00
9	0.33
3	0.33
4	0.00
10	-1.33
3	0.33
10	0.33
8	0.33
10	0.33
10	0.33
5	-1.33
6	0.33
1	0.67
8	1.00
7	-1.33
9	0.00
6.44	**0.07**

Welding	
Expected Score	*Score*
7	0.50
2	0.33
10	-2.33
4	1.00
4	-1.80
9	0.00
10	-1.60
3	-1.80
4	1.00
9	0.50
9	0.33
1	-1.50
7	-1.40
3	0.00
10	-1.33
8	-1.50
9	-2.50
5	0.33
5	-1.50
2	-2.00
3	0.33
0	-1.67
8	-2.00
7	-2.33
3	-1.40
10	-1.33
10	-2.20
5	-1.33
5	-1.50
5	-1.50
2	-5.00
8	-1.80
5	0.00
1	-3.50
7	-3.00
0	-2.50
7	-2.80
10	-1.67
9	0.00
6	-3.00
5.80	**-1.34**

Electrical	
Expected Score	*Score*
8	-1.40
1	-1.56
5	-1.60
6	0.25
1	-1.67
7	-1.11
10	-1.50
8	-2.50
9	-1.89
10	-1.60
2	-1.33
5	-2.50
9	0.44
0	-2.20
5	-1.50
10	-2.25
7	-1.25
10	-1.60
8	1.00
9	0.00
8	1.00
4	-2.33
3	-1.50
5	-1.50
10	0.33
6	-1.44
7	-3.00
2	0.00
10	-1.50
3	-1.22
8	1.00
10	-1.20
8	-1.20
5	-2.00
5	-2.20
7	0.00
9	-1.25
5	-1.80
5	-2.20
7	0.40
7	-1.56
9	0.25
7	-1.25
6.51	**-1.16**

Warehousing and Storage	
Expected Score	*Score*
7	-1.6
1	1
10	1
5	1
6	0.2
3	0.2
9	-1.5
8	-1.75
1	-1.2
4	-2
1	-1.75
5	0.25
5	-1.5
5	1
8	-2
10	1
2	-1.75
10	-1.6
9	-1.5
9	-1.75
9	1
8	-1.4
5	0
10	1
10	0.25
10	0
3	-1.25
3	1
8	1
6	1
9	0
10	-1.25
9	-2
3	-1.5
8	0.4
1	0.2
10	0.4
8	1
7	0.00
6.54	**-0.37**